VR2® Conductor Installation Guide

Southwire®

Introduction

This guide provides recommendations on procedures and equipment used during VR2® conductor installation. VR2 conductor can be installed using techniques and equipment similar to that used when installing standard round conductor. These general guidelines, together with those suggested in the IEEE Guide to the Installation of Overhead Transmission Line Conductors (IEEE 524TM –2016), will provide the basic information required to install VR2 conductor.

SPECIAL NOTE: The conductor clamps that are factory installed on the lead end and tail end of each reel must remain during installation in order to preserve the equal lengths between the conductors. Only remove the conductor clamps after the VR2 conductor has been installed.

2.0 VR2 CONDUCTOR STRINGING METHODS

There are several stringing methods available for VR2® conductors; however the method chosen must be appropriate for the installation requirements. A brief description of these stringing methods is described below.

2.1 Slack Method

The VR2 conductor reels are mounted on stands or jacks and are free to rotate with **only enough braking force to prevent overrun, backlash or loops.** The VR2 conductor is pulled off the reel by a vehicle that stops at each structure where the conductor is lifted and placed in a traveler mounted on the structure.

2.2 Layout Method

This method is similar to the slack method except the lead end of the VR2 conductor is tied off and **the reel is mounted on a vehicle which travels down the line paying out the conductor as it goes.**

2.3 Semi-Tension Method

This method follows the general procedure of tension stringing, except no tensioner is used. Minimal ground clearance is maintained by applying slight braking force to the conductor payout reel. Caution: The reels are not designed to withstand elevated tensions or high braking forces; therefore the conductor tension must be kept sufficiently low to prevent damage to the conductor or reel.

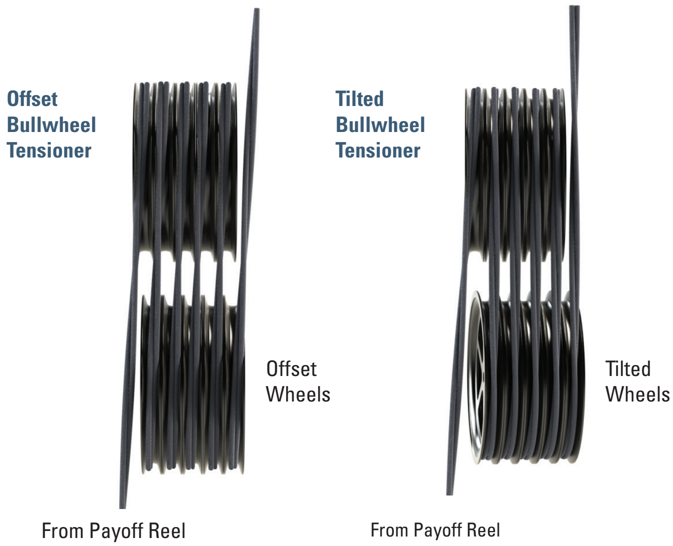
2.4 Tension Stringing Method

The tension stringing method is the most common installation method. This method consists of a pulling line threaded through a stringing sheave on each structure of the pulling section and connected to a swivel and pulling grip attached to the leading end of the conductor to be installed. The conductor is pulled through the sheaves of the stringing section as the pulling rope is wound onto the drum of a drum type puller, located at the pulling end of the stringing section. The pulling tension is regulated by the bullwheel tensioner located at the conductor pay out end of the stringing section between the conductor reel and the first structure. Only minimum braking force is applied to the payout reel to prevent over-run in the event of a sudden stop. This installation method keeps the conductor clear of the ground and other obstructions that could damage the conductor. Pulling tension should ideally be 10% or less of the conductor rated breaking strength. Pulling tension should never exceed the sagging tension. A good guideline is not to exceed 50% of the sagging tension.

2.4.1 Tension Stringing Equipment

When tension stringing VR2® conductor, a multi-groove tandem bullwheel tensioner is recommended. The alignment of the bullwheels should be offset by approximately ½ the groove spacing to allow proper tracking of the conductor around the bullwheels. Either the offset or tilted type bullwheel configuration may be used. The two primary considerations when selecting a bullwheel tensioner are groove radius and bullwheel bottom of groove diameter. Proper groove radius and bullwheel diameter are specified in IEEE 524. The maximum conductor diameter for VR2 conductor is twice the diameter of one component conductor.

Tensioners



- The groove radius must be **large enough so that the conductor, when laid flat, will fit into the groove. This can be verified with the bullwheel manufacturer.**
- The bullwheel sheave diameter must be large enough to avoid excessive bending of the conductor. **The recommended minimum bullwheel bottom of groove diameter should not be less than 35 times the maximum conductor diameter.**
- **Bullwheels must be synchronized to minimize conductor assembly separation** as it traverses the bullwheels. Also, the tensioner's braking system must allow for smooth, consistent tensioning of the conductor from stop to full payout speed and back to stop.
- For standard VR2 conductor (individual conductors with a right hand direction of lay and a left hand direction of lay for the twisted assembly) **the direction of wrap across the bullwheel should be from left to right.**
- **Two (2) or three (3) wraps of the conductor around the bullwheel should be sufficient for normal pulls**.
- The "V-Groove" style of tensioner cannot be used because **it will result in uneven tension in the twisted conductor assembly and likely damage the conductor assembly.**

2.4.2 Tension Stringing

Proper positioning of the stringing equipment is crucial for a good installation. The tensioner should be aligned with the sheave at the first structure and in line with the pull section. It is recommended that the angle of the conductor between the ground and sheave at the first structure be approximately 15 degrees, and should never exceed 25 degrees. Practically speaking, the tensioner should be positioned back from the first pole or structure a distance of three or four times the vertical height of the entrance stringing sheave.

For example, for a 15-degree angle, if the first sheave is at a height of 25 feet then the tensioner should be set back at least 100 feet from the structure. This practice will minimize the bending angle of the conductor and contact force between the conductor and the sheave, reducing the tendency of the conductor to separate.

The payout reel should be positioned in line with and behind the tensioner. The conductor payout reel should be positioned 50 to 100 feet behind the tensioner to allow the conductor to adjust from the circular wrap on the reel to a straight orientation before entering the bullwheel tensioner. **Care should be taken to avoid excessive bending around small fairlead rollers on the tensioner. Excessive bending around small rollers can result in permanent conductor damage.** The braking tension on the payout reel should be set only high enough to prevent overrun when the pull is stopped.

Excessive payout tension may distort or damage the conductor. If a guide roller is required to guide the conductor over other reels or obstructions, the guide roller or sheave should have a bottom grove diameter approximately 14 times the maximum diameter of the two conductor assembly.

3.0 SHEAVE REQUIREMENTS

Sheave selection is very important to avoid conductor damage and installation problems. The recommended minimum sheave bottom groove diameter should be 14 times the maximum diameter of the VR2® conductor assembly. The entrance sheave and angle sheaves, for angles greater than 15 degrees, should be larger. Proper size will be evident by smooth passage of the conductor through the sheaves, minimizing potential conductor bending and damage.

Use of improperly sized sheaves can result in excessive torsional twist in the twisted pair conductor as it is installed. The excessive twist can result in bagging of one conductor, a shorter lay length, and/or birdcaging. Unlined sheaves are preferred.

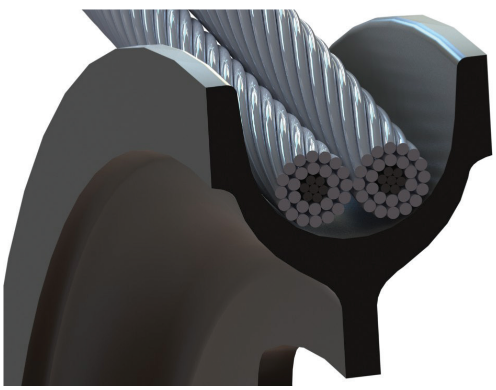
- Minimum groove radius: 0.55 times the maximum diameter of VR2 conductor assembly.
- This corresponds to a minimum groove diameter of 1.1 times the maximum diameter of the VR2 conductor assembly. This is to insure that both conductors in the side by side orientation can pass through the sheave freely as the conductor assembly passes through.
- Refer to IEEE 524TM–2003 for more sheave related recommendations.

Sheave Diameter Requirements

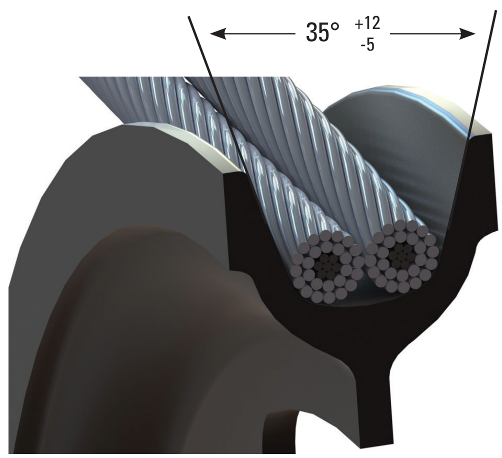
3.1 Optimum Sheave Profile

There are several sheave profiles in use today. It has been observed that "U" shaped profiles in some cases can provide too much freedom for the conductor to ride up the side of a sheave as the conductor travels through the sheave. Conductor assembly "climbing" is even more of a potential problem if a lined sheave is used and the lining grips the conductor. Based on field observations a sheave with "modified V" profile helps to resist climbing of the conductor as it passes through the sheaves.

See the figure below for the two different profile types. The "modified V" has a radius at the bottom but then transitions to sides like a "V". The bottom groove radius meets bottom groove radius requirements, but it has a quicker transition to the sheave sides which helps to keep the conductor assembly traveling in the bottom of the sheave and helps prevent potential "climbing" of the conductor assembly. The preferred included angle for the sides of the "modified V" style sheave is 35 degrees plus 12 degrees minus 5 degrees.



U Shaped Profile



Modified V Profile (optimum profile)

3.2 Sheave Linings

Sheave linings are not preferred because in some cases they can encourage conductor assembly rotation which can result in conductor damage. If sheave liners are used, a hard urethane liner with a Shore A hardness of 90 as a minimum has been shown to minimize conductor assembly rotation potential. Use of the optimum sheave profile as shown above further minimizes conductor assembly rotation potential if a sheave liner is used.

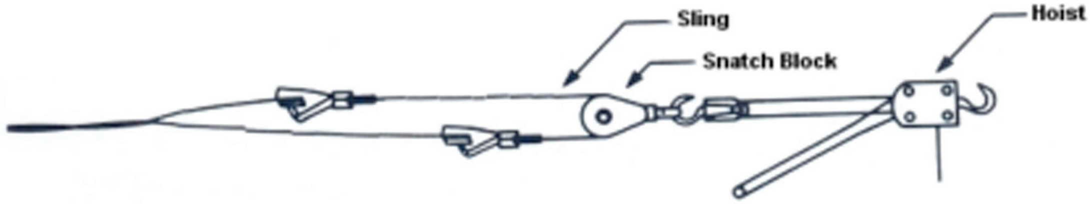
4.0 STRINGING VR2® CONDUCTOR

The conductor is shipped from the manufacturing plant with two metal band clamps on each end of the conductor. One clamp is near the end of the conductor and another clamp is located five (5) to ten (10) feet from the ends. It is important to keep both clamps on each end of the conductor during stringing to prevent relative movement of the component conductors. Otherwise, bagging or a "messenger" effect may occur in one of the conductors. The conductor pulling grip (Kellem grip) should be installed over the banded conductor. If the pulling grip will not fit over the conductor band clamps, additional band clamps should be installed on the conductor before the clamps installed at the factory are removed.

5.0 TENSIONING VR2 CONDUCTOR

During tensioning and or mid-span splicing of VR2® conductors, an equalizer sling must be used to maintain equal tension in each conductor.

- Separate grips must be placed on each of the component conductors. The two grips are then connected through a snatch block with a sling, as shown below:
- Pulling is done against the snatch block. This pulling assembly is often called an equalizer sling. This insures that both conductors take an equal share of the pulling load, which prevents unequal tension and helps maintain the relative positions of the component conductors. This will also tend to correct any change in relative component conductor position that may have occurred during the stringing process.



6.0 SAGGING VR2® CONDUCTOR

Presently accepted sag methods for standard conductors are satisfactory for VR2® conductor. Use sag values supplied by the Utility or by Southwire Company.

7.0 DEADENDING

There are a variety of different styles of deadend hardware available. Bolted type quadrant and compression type deadend clamps work well. However, always consult with the accessory manufacturer for the correct selection and installation procedure for the hardware.

8.0 SPLICING

VR2 conductor is joined by separately splicing the component conductors, with approximately 5 feet between the splices. Care should be taken to maintain equal tension on the component conductors to prevent them from separating. Always, consult with the accessory manufacturer for the correct selection and installation procedure for the hardware.

9.0 INSTALLATION TROUBLESHOOTING AND PRECAUTIONS

Potential conductor damage due to excessive conductor assembly rotation during installation is more common in larger conductor constructions such as 2 x 477.0 kcmil 26/7 ACSR/VR2 "Hawk" and larger. It is less likely in the smaller sizes. The smaller sizes can take more conductor assembly rotation during installation without creating potential damage to the wires in the outer layer. We recommend rigging all sheaves in angle structures to maintain the proper line of pull.

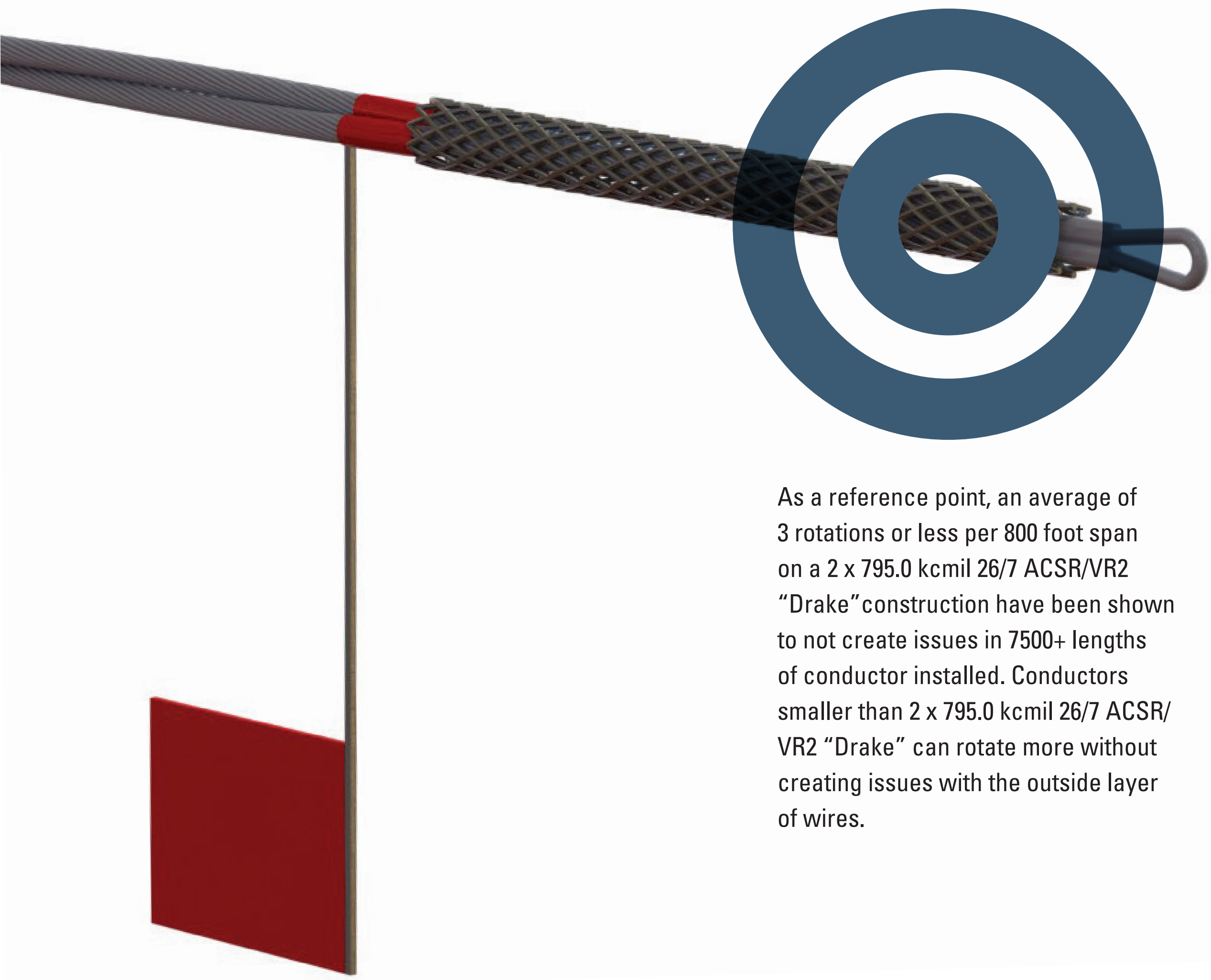
9.1 Individual conductors have outer layer strands that are overtightened (proud) or "opened up" (birdcaging) DURING OR after installation

Improper sheave selection or failure to use rigging on angle structures during installation can result in excessive conductor rotation creating excessive overtightening or "opening up" of the outside layer strands. This often will be more visible just past the bullwheel where the rotation on the fixed end accumulates and is stopped by the locking (anti-rotation) effect of the bullwheel.

The first troubleshooting step is to identify the direction and magnitude of the conductor assembly rotation. Using marking paint and a surveying flag if available, paint one side of the lead end of the conductor directly after the pulling sock has been installed over the factory conductor clamps. Install a small surveying flag too if available to help visually keep track of the conductor. This should all be done after the conductor has passed through the bullwheel tensioner. See the figure on the next page.

After the lead end of the conductor is clearly marked to allow the direction and number of rotations to be determined, start the pull while noting the number of rotations and direction of full 360 degree rotations of the conductor. Looking towards the puller, either clockwise or counterclockwise rotations will be observed within each span as it is pulled in.

As a reference point, an average of 3 rotations or less per 800 foot span on a 2 x 795.0 kcmil 26/7 ACSR/VR2 "Drake" construction have been shown to not create issues in 7500+ lengths of conductor installed. Conductors smaller than 2 x 795.0 kcmil 26/7 ACSR/VR2 "Drake" can rotate more without creating issues with the outside layer of wires.



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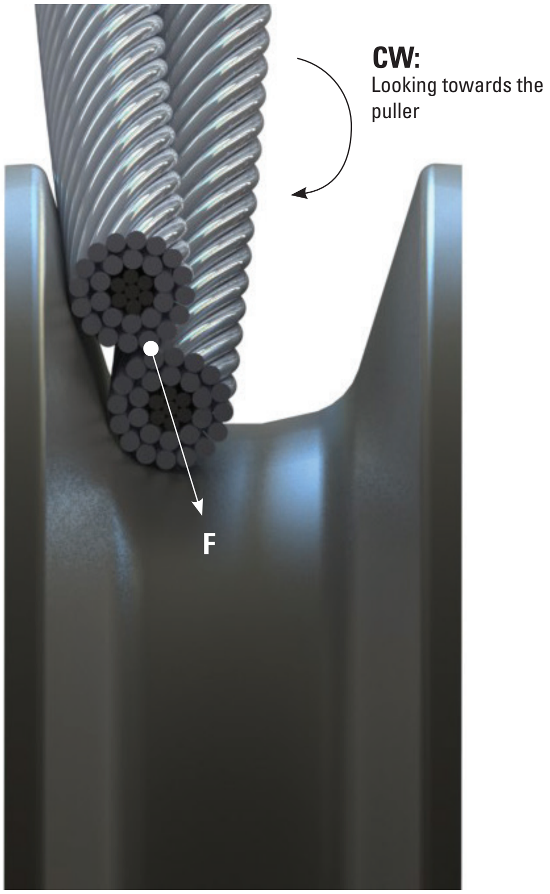
9.2 Excessive clockwise rotation likely causes

Excessive clockwise rotation results in “crowding” or “overtighening” of the outside layer of the individual conductors. One or more strands as a result may be raised or popped out of place.

If the pull does not involve angle structures, it is likely caused by the conductor not staying in the bottom of the sheave and riding more on the left side entering the sheaves when looking towards the puller.

(See figure to the right.)

If the pull does involve angles, failure to rig the block in the angle structures at the proper angle with a large turning angle to the left looking in the direction of the puller is a likely cause for the problem. The conductor assembly is excessively riding on the left side of the sheave as it has to work to keep the block assembly in position when it travels through.



9.3 Excessive counterclockwise rotation likely causes

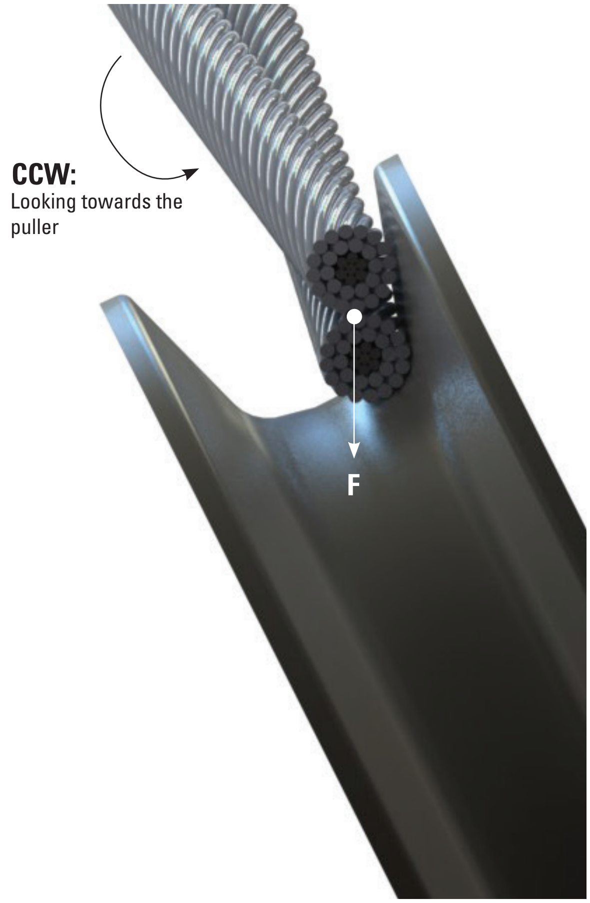
Excessive counterclockwise rotation results in opening up of the outside layer of the individual conductors and can result in an eventual birdcage in extreme cases usually right after the bullwheel tensioner where the torsion accumulation is at a maximum.

Excessive counterclockwise rotation can be caused by sheaves that are too small in diameter or with too small of a groove radius at the bottom.

Excessive counterclockwise rotation can also be caused by a failure to rig the block assemblies in the angle structures at the proper angle with a large turning angle to the right looking in the direction of the puller.

The conductor assembly is excessively riding on the right side of the sheave as it has to work to keep the block assembly in position when it travels through.

(See figure to the right.)



9.4 Further Precautions

The conductor clamps that are factory installed on the lead end and tail end of each reel must remain during installation in order to preserve the equal lengths between the conductors. Only remove the conductor clamps after the VR2® has been installed.

VR2 conductor consists of two component conductors twisted together with a lay that varies with conductor size. However, the lay may vary due to twist migration and conductor rotation during installation. In extreme situations this may result in separation of the component conductors, commonly called a bag. This rotation may be caused by factors including installation method, sheave diameter, tension and pole spacing. Identifying the point where bagging first begins is the first step in correcting the source of the problem.

Slight separation of the component conductors as it is paid off the reel and sometimes during stringing is normal. Tension equalization between the conductors during the stringing operation should correct the problem. If conductor bagging remains after stringing, these bags can typically be worked out during conductor tensioning. With the equalizer sling attached, bump the VR2 conductor with a rope to cause relative conductor movement. This should allow the bags to pull out. In the event of major conductor bagging, bags can be cut out and the component conductor spliced.

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